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AP 236

MINISTRY OF MUNITIONS.

**Department of Aircraft Production.**

**TECHNICAL DEPARTMENT.**

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**SECRET.**

**HANDBOOK OF  
"C.C." INTERRUPTER GEAR.  
TYPES A, A1 and B.**

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**CONSTANTINESCO FIRE CONTROL  
TIMING GEAR.**

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**SECOND EDITION.**

*MARCH, 1918.*



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VERY SCARCE

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# HANDBOOK OF THE "C.C." GEAR.

(THE CONSTANTINESCO FIRE CONTROL TIMING GEAR).

## DESCRIPTION.

The gear is made of the following units:—

The Generator, PLATE (1).

The Trigger Motor, PLATE (2) and (5).

The Reservoir; with Bowden Control (49) PLATE (3).

The Main Pipe Line (50)

The Secondary Pipe Line (51) } PLATE (4).

THE GENERATOR, PLATE (1), consists of a shaft and cam (1) running in bearings (5) and (6) in the Aluminium casing (2) and actuating the piston (4) in the cylinder (3) which is screwed into the casing (2).

An oil retaining cover (7) is provided and holes are drilled in the bearings and hollow cam shaft to facilitate lubrication. The oil enters the hollow shaft as far as the cork (68) and is swung out into the bearings, thus providing a continuous circulation of the oil. The gland (12) and gland nut (11) are provided to make the generator oil-tight.

THE TRIGGER MOTOR types A and A1 PLATE (2) are attached to the back of the Vickers gun so that the slots in their plungers (14 and 57) engage with the new trigger bar lever (26) provided with the gear, and is held by the two screws (Nos. 60 and 61 in Vickers .303 Machine Gun Handbook). Type A consists of the plunger (14) packed by a U packing ring (18) and working in a cylinder against the action of the strong square section spiral spring (16) which limits the forward movement by being compressed coil on coil. In the later trigger motors Type A1 the spiral spring (55) is of round section and a collar (56) on the plunger (57) limits the length of the stroke forward. The back of the plungers (14 and 57) are conical and is held by the spring (16) against the valve seat (20) in the T piece (21) at the back of the trigger motor. The T piece (21) contains the damping valve (25) spring (24) and a needle valve (23) for releasing air from the system. The main pipe line (50) is soldered into the T piece (21).

The TYPE B TRIGGER MOTOR is attached to the barrel casing and to the front cover of the Vickers gun, and is arranged so that its push rod works directly on the trigger, through a slot cut in the rear cover of the gun.

It consists of a plunger guide bracket (69), attached to the barrel casing of the gun as shewn in PLATE (5) with four screws and forming a guide and cylinder for the plunger (70).

The plunger guide bracket also holds the U packing ring (18), the retaining ring (19) and provides the thread on to which the Union nut (9) of the Tee piece (21) is screwed. The back of the plunger is flat and seats over the hole in the tail piece (20).

The trigger push rod bracket (71) is attached to the front cover of the gun with six screws.

The steel trigger push rod guide (72) is a tight fit in this bracket and provides a bearing for the trigger push rod (73) and its mushroom head (74).

The trigger push rod (73) is inserted at the rear end of the guide (72) and the spring over the front end.

The trigger push rod mushroom head (74) is then screwed over the trigger push rod against the action of the spring.

When the front cover is closed the rear end of the plunger (70) is in contact with the centre of the mushroom head of the trigger push rod, and the front end is pressed by the spring against the tail piece (20).

The trigger push rod locking clip (75) is sprung into position through the hole (76) in the bracket and guide and prevents the trigger push rod from unscrewing out of the mushroom head.

THE RESERVOIR, PLATE (3) consists of the brass tube (27) forming the low pressure reservoir and provided with the filling tube and cap (37). It is screwed into the casting which consists of the high pressure reservoir (28) and the body of the control valve. The piston leather (30) on the rod (29) works in the high pressure reservoir or cylinder (28). The piston is pulled up by the handle (34) against the action of the tension spring (33) the upper end of which is anchored to the piston rod (29) and the lower end to the bottom of the brass tube. The high pressure reservoir is bell mouthed at the top to allow the leather (30) to be drawn clear and admit liquid contained in the outer tube or low pressure reservoir into the



high pressure reservoir below the leather. A passage connects the bottom of the high pressure reservoir to the space behind the high pressure ball valve (44) which is held in position by the spring (45) and plug (46). Another passage connects the low pressure reservoir through the hole (59) to the space (60) and to the secondary pipe connection (48). A needle (42) can be moved by the Bowden Control through the hole (59) which forms the low pressure valve thus closing the passage between the low pressure reservoir and the pipe connection (48). A further movement of the needle will displace the high pressure ball valve and allow the liquid in the high pressure reservoir to be forced by the piston leather (30) through the pipe connection (48) to the secondary pipe line. When the needle is withdrawn it first allows the high pressure ball valve to close, and then opens the low pressure valve, by withdrawing through the hole between the pipe connection (48), and the low pressure reservoir.

## IMPROVED NEEDLE VALVE ARRANGEMENT FOR THE RESERVOIR.

The old type of needle (42) is cut short as shown at (77). (Plate 7). The new low pressure needle valve (79) is fitted and a ball (78) inserted between the two needles.

The low pressure needle valve accurately fits the hole (59) for a distance of five mm. at the Bowden Control end but for the remainder of its length has two flats made on it.

When the Bowden Lever is released, the needle (77) is held away by the spring (40) the ball (78) is touching it and the low pressure needle is in contact with the ball.

In this position the secondary pipe line is connected by the space left open due to the flats on the needle (79) to the low pressure reservoir.

When the Bowden Needle is operated the needle (77) pushes the ball (78) and needle (79) forward.

The fitting portion of the needle (79) enters the hole (59) and closes the connection between the pipe line and low pressure reservoir.

Further movement displaces the high pressure ball valve and also holds the low pressure ball (78) against the hole (59) and holds up any leakage past the needle (79).

When the Bowden Lever is again released, the pressure in the line acting on the needle (79) forces the needle and ball (78) away, and the action of the gear stops in the usual way.

The advantage of this design is that there is not so much accuracy required in lining up the various parts and a badly fitting needle is not so serious.

In assembling great care must be taken that the ball (78) is held properly in position in the end of the Control Cylinder (38) by means of grease or some other method while the Control Cylinder is being screwed in, otherwise the ball will be pinched between the end of the cylinder and the brass casting and cause great damage.

PIPE CONNECTIONS, PLATE (4). The *main line* consists of a  $\frac{1}{4}$ " bore copper pipe (50), connecting the generator cylinder to the trigger motor. The *secondary line* is a  $\frac{1}{16}$ " bore copper pipe (51) connecting the pipe connection (48) at the bottom of the reservoir to the main pipe line at the generator union (10).

All the joints are usually made with soft solder. Silver solder may be used if great care is taken not to burn the copper pipes.

## ERECTION.

THE GENERATOR is usually held by a bracket (61) PLATE (1) bolted to the crank case or some convenient part of the engine so that a gear wheel (62) fastened to its cam shaft coupling flange (13) can be driven at twice the propeller speed, by a gear ring (63) bolted to the propeller boss by the boss bolts. The gear wheel (62) which is to transmit the drive to the generator shaft, has 15 holes drilled in it at the same pitch circle diameter as the 18 holes drilled in the splined coupling flange (13). When the wheel is in position three bolts can always be fitted through the wheel and flange, and a vernier adjustment of  $\frac{1}{8}$ th of a revolution is thus provided. The drive is transmitted from the gear wheel through the three bolts to the coupling and then through the splines to the cam shaft. The wheel (62) and flange (13) are located laterally either by taper pins or better, by the split ring method shown in PLATE (1). The boss (66) of the wheel (62) is bored to be a push fit on the generator shaft, and is as long as possible provided it can be pushed along the shaft until its face (67) is clear of the groove (64) turned in the shaft. A



split ring (65) is then placed in the groove (64) and its outer diameter stands proud of the shaft. The boss of the gear wheel is bored out for a sufficient length to clear the split ring so that the wheel can be withdrawn along the cam shaft over the split ring until its face (67) is flush with the end of the cam shaft, but no further. When the coupling flange (13) is pushed into the splines and bolted to the gear wheel (62) they are both definitely located laterally. The cylinder (3) must be arranged to be pointing as nearly vertically downwards as convenient, so that the pipe line can be led away by easy bends and without any chance of an air lock.

The lubricating oil filling hole and plug (8) must be placed so that the oil can be conveniently filled through it before each flight. The oil retaining cover (7) can be moved round and re-bolted in a convenient position, and a pipe fitted to the union filler if necessary. The generator must be  $\frac{7}{8}$  filled with thin engine lubricating oil. If the generator is dismantled all its joints must be carefully treated with shellac or dope before re-assembling.

The gland nut (11) should be locked by a small angle plate held under the head of the bolts (52), and bearing against one of the flats of the hexagon. It could also be wired to one of the bolts. Some such means must be provided to secure it.

In some cases the generator is driven at propeller speed from some suitable place on the engine. A special generator with two high places on the cam has then to be used to give the same rate of fire.

THE TRIGGER MOTOR, Types A. and A.1., PLATE (5). The Vickers Gun is prepared for receiving the trigger motor Types A. and A.1. by removing parts 25, 13, 59, 60, 60A, 61, 62, 63, 12, and 14 (see Vicker's Hand Book).

The small bridge piece holding the safety catch spring (50 Vicker's Hand Book) in position must be filed away. The hole through which the plungers (14 and 57) pass must be enlarged to be a clearance hole for them.

The trigger motor is fitted to the back of the gun by securing it in the place of parts 12 and 14 (Vicker's Hand Book) with the screws 60 and 61 (Vicker's Hand Book) and with its plunger passing through the rear cross piece of the gun, the slot being vertical. The new trigger bar lever (26) is

placed in position with its forked end upwards, the wider arm of the fork being to the front, and with its lower end engaging in the slot of the trigger motor plunger.

The T pin (25, Vicker's Hand Book) is then replaced and the union nut (9A) of the T piece is tightened up on the back of the trigger motor. The plunger will be seen to be pushed forward slightly and to move the trigger bar lever so that the lug on the trigger bar (52 Vicker's Hand Book) engages in the fork when the lid of the gun is closed. The action of closing the lid must draw the trigger bar slightly backwards.

The following points must be particularly watched during fitting:—

- (1) Fit the trigger motor body and plunger without the spring. Move the plunger and see that it is perfectly free throughout the length of its stroke. The plunger moves in some cases 4,000 times per minute and absolute freedom is essential.
- (2) See that the trigger motor attachment is quite rigid when bolted up. Insert thin tin washers between the back of the gun and the attachment if necessary.
- (3) Open the rear cover, fit the trigger bar lever and see that the plunger and trigger bar lever are quite free throughout the length of the stroke.

Any tendency for the lower end of the trigger bar lever to bind in the slot of the trigger motor-plunger must be remedied by rubbing it down with emery cloth. It is of the utmost importance that all those parts should be absolutely free because of their rapid movement.

4. Open the rear cover of gun, take out the trigger bar, hang the lock, and place the trigger bar on the lock with its projection in the slot of the trigger bar lever. Move the trigger bar throughout the length of its stroke and see that it is not lifted from the lock by its projection being pinched by the jaws of the trigger bar lever when at its rearmost position. Open out the jaws if necessary, taking great care that the front jaw bears evenly all the way across the projection on the trigger bar lever.

5. Replace the trigger motor spring, set the top of the trigger bar lever at the back of its stroke, shut the rear cover with the trigger bar in its guide way, and with its projection out beyond the rear cross piece. Try to slide the trigger bar



into position past the rear jaw of the trigger bar lever, taking care that while so doing the top of the trigger bar lever does not move forward from the back of its stroke, and also that the rear cover does not lift.

If the projection on the trigger bar will pass the jaw, the trigger bar lever is faulty and should be replaced.

6. Cock the lock and place the trigger bar on the lock with its projection in the jaws of the trigger bar lever. Press on the back of the trigger motor plunger and see that the trigger is tripped about a millimetre before the plunger reaches the end of its stroke. Grind the trigger motor spring if necessary to lengthen the stroke.

In the new type A1 trigger motors with the stop on the plunger and the round section spring, either the stop on the trigger motor attachment or on the plunger must be turned down to lengthen the stroke. This will very rarely be necessary.

7. Screw up the T piece on to the back of the trigger motor body and see that the top of the trigger bar lever is drawn back during the last few turns of the union nut.

If the top of the trigger bar lever is not drawn back, the back of the trigger motor plunger cannot be seating on the tail piece, and the cause of this should be found out and remedied.

8. When the T piece is nipped up tight, close the cover of the gun with the trigger bar in its slide, but without its spring and the cover catch. Insert the cover catch screw in place of the trigger bar spring, and use it as a feeler to see that the trigger bar is drawn slightly to the rear when its projection enters the jaws of the trigger bar lever. The sharp edges on the projection of the trigger bar are to be slightly rounded off to enable it to enter the jaws easily. If the trigger bar is not drawn back or will not enter the jaws of the trigger bar lever see upon which jaw it catches.

If it catches on the rear jaw or goes straight in without being drawn slightly back in so doing, the top of the trigger bar lever is too far forward.

This may be remedied by turning off the necessary amount of the thread of the trigger motor body and so making it possible to screw the trigger motor body further into its attachment thus drawing the top of the trigger bar lever back.

If the projection catches on the forward jaw, a washer must be fitted between the trigger motor body and its attachment. This will scarcely ever be necessary.

9. Place the trigger bar on the lock with its projection in the jaws of the trigger bar lever and see that the trigger is slightly clear of the trigger bar. If there is any difficulty about this, the trigger motor body must be adjusted so that it gives the best possible adjustment for both (8) and (9), or the trigger bar may be filed.

TRIGGER MOTOR, Type B. PLATE (5). The Vickers gun is prepared for receiving the Type B Trigger Motor by removing the trigger bar and as much of the remainder of the ordinary firing mechanism as may be desired.

A hole is cut in the rear cover of the gun as shewn in Plate (6). Care must be taken that in cutting through the hinge a bridge piece must be left to take the compression caused by screwing up the cover axis pin.

The plunger guide bracket and the trigger push rod guide bracket are to be offered up in position and the centres of the holes required in the barrel casing and the front cover of the gun marked off so that they are both truly in the centre line of the gun and so that the claws on the plunger guide bracket touch the rear end of the barrel casing and that the front end of the trigger push rod guide bracket will just clear the barrel casing and the plunger when the front cover is opened.

The brackets are then to be set so that the plunger and trigger push rod are as nearly as possible in line. A light packing under the trigger push rod bracket or some fitting of the plunger bracket may be necessary.

The plunger, the trigger push rod and the mushroom head assembled without the spring are to be tried for absolutely free movement without any tendency to stick. The cause of any stiffness is to be found and removed.

The trigger push rod is to be set so that it is just clear of the trigger of the gun when it is in contact with the plunger while this is touching the tail piece.

The trigger push rod is to be drawn back until the mushroom head comes in contact with its stop and the trigger should then be one millimetre or so past its tripping position.



The position of the trigger push rod can be adjusted either by taking out the locking clip and turning it, or by opening the front cover of the gun and turning the mushroom head.

To close the front cover it should be necessary to compress the spring by pressing on the mushroom head and when closed the mushroom head should press the plunger firmly up against the tail piece.

The trigger push rod and plunger should be freely oiled daily.

THE RESERVOIR is to be fitted in as nearly vertical a position as possible and so that the pilot can pull up the handle without difficulty. The reservoir should not be set at more than  $45^\circ$  from the vertical, unless it is impossible to do otherwise.

The handle of the reservoir will stop in all positions from the top of its stroke to the bottom, according to the number of bursts fired and it must therefore be absolutely clear of all controls, etc., of the aeroplane in any of these positions, in whatever position they may be in.

The Bowden Cable is to be thoroughly greased and led away from the bottom of the reservoir without any sharp bends, and should be cut as short as possible. The secondary pipe line is also to be led away without sharp bends. The filler cap at the top of the reservoir is to be accessible to an ordinary petrol syringe for the purpose of filling. The whole reservoir is to be rigidly mounted to withstand the pull on the handle.

THE PIPE LINE. PLATE (4). The main pipe line 50, is to be led from the generator union to the trigger motor with as easy bends as possible and to be set with gentle rises from one low point so that there is no possibility of causing an air pocket when the line is filled. The secondary pipe line is to be led away from the generator alongside the main pipe line as far as possible and bound securely to it with whip cord. Insulating tape is weakened by oil and is not suitable. Both pipe lines are to be secured wherever possible and rubber or leather packing is to be used under all clips and binding to prevent chafing of the pipes. The length of the main line should not be less than 6 feet and of the secondary pipe line not less than 6 feet. The secondary pipe may be bent in wide coils to use up the length if necessary. Great care must be taken that the soldered joints are not strained during the

bending of the pipes or the nipping up of the unions. If it is necessary to cut down the lines as supplied the surplus lengths are to be cut off from the generator end, as great care is needed at the Tee Piece end to prevent pieces of solder fouling the damping valve.

FILLING. The Gear is to be filled with a mixture of oil and paraffin, 10% of B.B. Engine Oil and 90% good quality paraffin is a satisfactory mixture. If any trouble should be found due to the mixture thickening up at a great height in very cold weather a mixture of about the same consistency made from paraffin and P.924 non freezing oil can be used. It is essential that the oil and paraffin should be very carefully mixed and strained through a fine mesh gauze. It should then be kept covered up till used. The use of a dirty mixture will cause trouble in the working of the valves at the bottom of the reservoir. The union nut at the generator end of the pipe line is to be slackened back one turn, and the air release valve at the trigger motor end opened. The reservoir is then filled with the clean and well strained mixture through the filling hole provided. A petrol syringe is useful for filling purposes. The handle (34) is then pulled up to the top and released. It will fall a short distance and remain steady holding some of the mixture under pressure in the high pressure reservoir. The mixture so contained will be forced into the main pipe line through the secondary pipe when the Bowden Lever is pulled. The handle (34) should be prevented from rushing down rapidly by holding with one hand when the Bowden is pulled by the other. This will make the mixture enter the main line gently and carry the air steadily up the pipe ahead of it. The process of pulling up the reservoir handle and lowering it slowly when the Bowden Lever is pulled is repeated, refilling the reservoir when necessary, until the mixture flows freely and clear from air at the generator union. The union is to be nipped up while the mixture is actually running from it. The process is then repeated until the mixture flows from the air release valve, which is also to be screwed down during the actual flow of the mixture from it. If these operations are carefully carried out the gear will be completely filled with the mixture and will be free from air. If there is no air in the pipe lines each time the Bowden Lever is operated the reservoir handle will fall rapidly a short distance only and then stop rigidly. If the handle falls a long way and comes to rest slowly the air release valve should be opened and the process of filling repeated.



**TIMING THE GEAR.** After the Gear is filled the propeller is withdrawn a short distance on its shaft so that the gear ring is out of mesh with the generator gear wheel. The reservoir handle is pulled up to the top of its stroke and released, and the Bowden Lever is then operated and released. The pipe lines have thus been put under pressure and the generator piston has been pushed along its cylinder into contact with the low part of the cam. The generator gear wheel is now turned slowly by hand. The high part of the cam coming in contact with the piston will easily be felt. The wheel should then be turned very slowly until the piston is pushed to the end of its stroke. If the wheel is turned slowly backwards and forwards about this position the point at which the highest part of the cam is just touching the piston will be readily found. The propeller is then set in the correct position relative to the gun, and its gear ring meshed with the generator gear wheel set with the cam touching the piston at its highest point. With a two bladed propeller it is usually sufficiently accurate to take the nearest tooth, but with a four bladed propeller it will probably be necessary to use the vernier adjustment provided between the generator gear wheel (62) and the coupling flange (13) by withdrawing the three bolts and replacing them in the correct position.

**ACTION OF THE GEAR.** The gear is now ready for trial and may be tested without firing the gun if the rear cover is opened or in the case of the trigger motor attached to the front cover of the gun, by hanging the lock. When the engine is started the generator cam pushes the piston to the bottom of its stroke. Until the Bowden Lever is operated the main pipe line is connected through the secondary pipe and the hole (59) in the low pressure valve to the low pressure reservoir, and is under atmospheric pressure. The generator piston therefore remains at the bottom of its stroke and out of contact with the cam as there is no pressure in the pipe to return it. When the Bowden Lever is operated the needle (42) moves forward through the hole (59) and shuts off the pipe lines from the low pressure side. Further movement of the needle opens the high pressure valve (44) and the mixture held under pressure in the high pressure cylinder is forced through the secondary pipe into the main pipe line. The main pipe line is then under a pressure of about 150 lbs. per square inch and the piston of the generator is forced into contact with the cam. At each operation of the cam the mixture, immediately

in contact with the piston is compressed and a wave of pressure travels along the pipe line to the trigger motor, with the velocity of sound through the mixture, that is at about 4,000 feet per second. The wave lifts the damping valve (25) and impinges on the back of the trigger motor plunger (14). Only about quarter of the area of the plunger is acted upon by the wave when it is tight upon its seat. If the wave is weak, as may be the case with the first one or two while the Bowden Lever is being operated, it will be unable to move the plunger when acting on the small area exposed, and the weak wave is reflected back. As soon as the wave is strong enough to move the plunger slightly it acts upon four times the area and therefore with four times the force on the plunger. This arrangement makes the plunger either move rapidly throughout its stroke or not at all, and as the movement of the plunger draws the trigger bar back and pulls the trigger it eliminates the chance of a late shot due to a slow movement. The Damping valve (25) is shut by the spring (24) as soon as the wave has passed. The wave has then to return through the small hole drilled down the centre of the valve and is so damped out. The necessity for this damping valve was made clear in the early experiments as stray shots were found, which proved to be caused by the wave being reflected from the trigger motor plunger to the generator and back. In this way the trigger motor plunger was occasionally operated two or three times by one movement of the generator. No trouble has been experienced since the valve was fitted. The action of the gear continues as long as the Bowden Lever is held pulled and maintains the pressure in the main pipe line thus keeping the generator piston in contact with the cam. When the Bowden Lever is released the high pressure valve (44) is closed by the spring (45) and shuts off the high pressure reservoir from the pipe line, but still leaving the liquid in the pipe line under pressure. The needle is then withdrawn from the hole (59) and by so connecting the pipe lines to the low pressure side allows some of the liquid under pressure to pass into the low pressure reservoir and the action of the gear stops, the piston remaining out of contact with the cam. This action is repeated each time the Bowden Lever is operated, the high pressure reservoir supplying sufficient mixture each time to make up the displacement of the generator piston and push it into contact with the cam. If all joints are tight no mixture



flows from the high pressure reservoir during the bursts but only at the beginning of each burst. The reservoir should give at least 10 bursts with one pull up of the handle.

The adjustment of the Bowden Cable should be set so that the gun ceases to fire immediately the lever is released.

If this adjustment is carefully done and the Bowden Lever is released slowly it will be noticed that just as the Bowden Lever is released the reservoir handle is pumped up slightly and many more bursts are obtained with one pull up of the handle, due to the line not being immediately connected to the low pressure side and the ball valve (44) acting as a non-return valve.

This adjustment must not however be set too fine or the pressure will be maintained in the pipe line long after releasing the Bowden Lever, and although not being able to fire the gun, due to the back of the piston reflecting the weak waves will keep the generator piston in contact with the cam and cause excessive wear of the generator piston ball, cam and bearings.

## DAILY CARE OF THE "C.C." GEARS AND VICKERS GUNS

The following instructions should be followed out each day before the aeroplane engine is started. Failure to do so will result in unsatisfactory working of the gear and gun.

The numbers and letters referred to are those given in the "C.C." Gear Handbook.

1. Fill up the Reservoir through the filler tube (37) each morning with the special mixture (90% paraffin and 10% B.B. oil CAREFULLY MIXED AND WELL STRAINED). Usually very little of the mixture, if any, will be required. An excessive amount required denotes that leakage has occurred either at the needle (42) and gland (41) or in one of the joints of the system, and the fault should be found at once.

2. Fill up the oil chamber on the generator with Mobiloil "A" through the filling union at (8).

3. Pull the handle (34) of the Reservoir. When released it should remain steady after falling a short distance.

4. Pull the Bowden control (49). The handle (34) of the Reservoir should fall a short distance only and then remain steady as if it had hit on something solid.

Deal with any failure of the handle to behave as stated in 3 or 4 according to the fault table.

5. Inspect trigger bar and trigger bar lever to see if bent or broken.

6. Dry clean the barrel each morning.

7. Replace the lock of the gun. Oil with (P.924) non-freezing oil only.

8. Check the timing each day by pulling up the Reservoir handle, pressing the Bowden control and watching the movement of the Reservoir handle while the propeller blade is moved past the point of aim. The handle should be at the top of its movement when the blade is in the correct position. This position will vary slightly with different types of aeroplanes, but will usually be with the blade opposite the barrel of the gun.

9. Take out the lock at night and store it in the armoury. Trip sear and trigger to release tension of lock spring.

10. Clean the barrel as soon as possible after firing and leave it oily. (Barrel will always be left oily overnight whether the gun has been fired or not.)

11. Let down the Reservoir handle (34) each night, to release the tension of its spring, by repeated operation of the Bowden control. Move the propeller blade past the point of aim after each movement of the Bowden control if there is any difficulty.

12. Remove, clean, and oil with P.924, the recoiling portions every time the gun has been used if the position of the gun in the aeroplane allows of it and in any case as often as possible.



## C.C. Gear Fault Table.

Failure in the Gear is always shown by the behaviour of the Reservoir Handle and can be easily localised.

Notification.	Action.	Fault.	Repairs.
1. After pulling Reservoir Handle to the top of its stroke it sinks at once to the bottom without operation of Bowden Control	Unscrew filler cap, fill up Reservoir and expel air from the system	Not enough liquid in the Reservoir	
2. After pulling Reservoir Handle to the top of its stroke, it sinks slowly without operation of Bowden Control	Press Bowden Lever halfway:— If this stops the fall  If it does not stop the fall, press Bowden Lever fully home. Reservoir Handle will drop quickly about an inch. If handle then falls at the same rate as was noticed before pressing Bowden Lever. If handle falls quicker than before Bowden Lever was pressed	High Pressure Valve leaking due to:— Grit under Ball Valve, or Damaged Valve Seating.  Damaged U Ring (30) at foot of High Pressure Piston. Leak in line in addition to High Pressure Valve leaking.	Clean Valve Seating.  Tap the Steel Ball with a copper drift to bed it on to the seating.  Fit new Ring (30).  Go round all unions and screw up, if leak is found in Copper Pipe lines or joints, change pipe lines.

## C.C. Gear TABLE, continued.

Notification.	Action.	Fault.	Repairs.
3. After pulling Reservoir Handle to the top of its stroke it remains steady, but on pressing Bowden Control it sinks slowly to the bottom.	Fill up Reservoir until oil is level with top of filler tube at (37) Press Bowden Lever fully home. If oil overflows at point (37).	Low Pressure Valve leaking due to either a damaged needle (42) or a worn low pressure port.	Fit a new needle (42) or a new Valve Box to bottom of Reservoir.
4. When Bowden is pressed handle of Reservoir drops too far and does not come to a definite stop.	Open Needle Valve (23), hold Reservoir Handle press Bowden Lever, and let handle of Reservoir down slowly until liquid flows through needle Valve (23) free of any air bubbles.	Air in the system.	

NOTE.—If after standing overnight the Reservoir is found to have emptied itself, the leak is probably in the union of small bore pipe to Reservoir, or at the leather through which the Control Needle passes. If the latter, the leather must be replaced.

Re action given for Notification (4):—Be careful to close Needle Valve (23) while liquid is still being pressed through. If any difficulty is experienced in expelling all the air from the system, run the engine with all the unions and Needle Valve tightened up, pull up handle (34) and operate the Bowden Control about 30 times. Stop the engine and repeat action as given.



## GENERAL REMARKS.

Stray shots are more likely to be caused by lack of attention to the gun than by faults in the gear.

The chief cause of stray shots in the gun is due to the caps of the cartridges being lightly or eccentrically hit by the firing pin of the lock. When this happens a cap will burn slowly or will misfire.

It has been found that the sear of the lock can be released even if the extractor is not absolutely up against its stop.

When this happens and the firing pin is released by the trigger it has to force its way through the coned hole in the extractor and is thereby slowed in its movement forward and is bent down.

The following faults will tend to make the extractor fail to come fully up against its stop:—

- (a) Thick rim cartridges.
- (b) Protruding cap.
- (c) Fault in feed preventing recoiling portions getting home, and extractor horns therefore catching against the underside of the solid cams.
- (d) Too light a fusee spring.
- (e) Recoiling parts too heavy.
- (f) Badly adjusted connecting rod.
- (g) Faulty fitting of empty link chute.
- (h) Weak lock spring.

Any of these faults will therefore tend to cause the firing pin to be slowed down and one of the following three things will happen:—

(1) The firing pin is slowed down slightly but hits the cap sufficiently hard to fire it properly. The slowing down will cause a late shot.

*NOTE.* At 1200 revolutions per minute  $1/1000$ th of a second delay will cause the shot to be 7.2 degrees late.

(2) The firing pin is considerably slowed down, the cap is slightly hit, and the fulminate burns instead of detonating. This causes a hang fire and very wide shot.

(3) The firing pin is completely slowed down and causes a misfire.

In order to reduce the chance of a stray shot to a minimum the ammunition should be carefully gauged and examined before use.

The weight of the recoiling parts should be made as low as possible, certainly not more than two pounds, by packing the barrel with from 6" to 8" of packing in the front gland and two turns in the form of a clove hitch in the cannellure.

The fusee spring tension will vary with different guns but about 9lbs. should be used.

With the screwed muzzle cup and heavy recoil washer the tension may be raised slightly higher without causing No. 1 stoppages at a height.

Only P.924 oil should be used.

## SUMMARY.

The foregoing notes may be summarised as follows:—

1. A Synchronised Fire Control so controls the mechanism of the gun to which it is attached as to make its fire semi-automatic instead of automatic; that is the trigger is tripped by the gear for each individual shot fired, the tripping of the trigger being so timed relative to the speed of the propeller as to ensure that no blade is in the line of fire at the moment the bullet passes through the plane in which the propeller revolves.

The correct position of propeller varies with different types of machines and according to the minimum and maximum propeller speeds between which the pilot may require to fire his gun.

2. *Fitting of Gear.* Generator is usually fitted to a bracket which is in turn fastened to the crank case. Generator usually runs at twice propeller speed. Generator spur wheel usually fitted to Generator Cam Shaft by means of a split-ring and a coupling, or by means of the coupling and taper pins driven through the Cam Shaft and coupling spindle. These pins to be then riveted over. Generator to be fitted with pipe line connection to the bottom if possible. See that Gland Nut has some locking device.

3. *Preparing of Gun.* Take off Firing Lever, Firing Lever Pawl, Safety Catch, Safety Catch Spring with Piston, and Trigger Bar Lever.

Open out pawl way.



File away bridge piece above the safety catch spring.

4. Fit Trigger Motor without Spring and see that Banjo Piece is firm, and that the plunger works freely. Fit C.C. Type Trigger Bar Lever. See that it has very little play in every direction, and again see that the plunger is quite free through the length of its stroke. Take Trigger Bar out, hang the lock and lay Trigger Bar on the lock with its lug in the slot of the Trigger Bar Lever; move the plunger through its full stroke, and see that the Trigger Bar does not lift. If it does, then open out with a file the jaw of the Trigger Bar Lever.

5. Set the Trigger Bar Lever at the rear end of its stroke and with the Trigger Bar in its guide way, having its projection beyond the rear cross piece. Then see that the Trigger Bar cannot be pushed past the rear lip of the Trigger Bar Lever.

6. Replace Trigger Motor Spring and see if when plunger is pushed fully forward the lock will trip and allow approximately 1mm. movement of the Trigger Bar beyond. (Correction: grind spring, or with new type turn down the seating on Banjo Piece.) Assemble tee piece to Trigger Motor Body and see the top of Trigger Bar Lever moves backwards slightly as the union is finally tightened up.

Check to see that Trigger Bar is drawn back slightly on closing the rear cover (using the rear cover lock axis pin as a feeler). Check clearance between Trigger and end of slot in Trigger Bar. This should be approximately 1mm.

7. *Reservoir.* Fit so that handle clears all controls in all possible positions of both the handle and controls.

Set as nearly vertical as possible, provided it is handy for the pilot to reach and pull up the handle. If possible it should be fitted not more than 45 degrees from the vertical when tail of machine is resting on the ground.

See that the Bowden Cable can be led away as straight as possible and that the filler cap is accessible with a petrol syringe.

Bowden Cable should be well greased before putting into its casing. The Reservoir should be very firmly fastened to the machine.

8. *Pipe Lines (Main Line).* Lead away with as easy bends as possible and with a steady rise so that no air pockets can be formed. Clip securely whenever possible, placing rubber or leather between the clip and the pipe.

(Secondary Line). Bind with whipcord to main line as far down the pipe as possible.

Lead to Generator Union as gently as possible.

Take great care not to strain soldered joints.

9. *Filling.* Mixture to consist of 90% of paraffin to 10% of B.B. Mobiloil. In extreme cold weather it may be found advisable to use P.924 oil in place of B.B., mixing the oils in such proportions as to give approximately the same density to the mixture as when using B.B.

*NOTE.* It is very important that the mixture should be well strained before pouring into the Reservoir, as the least particle of grit is likely to prevent the high pressure valve from closing. In order to expel air from the pipe lines, etc., after filling the whole system with oil, slightly loosen the Generator and Trigger Motor Unions and Needle Valve, and pin these up again in the order given when you are satisfied that the oil is flowing out free of air bubbles. It is very important that these three places should be tightened up while oil is still flowing out.

Let down handle of Reservoir slowly, keeping the Bowden Lever pressed, while tightening up unions.

10. *Timing the Gear.* Pull up Reservoir Handle to top of its stroke and press Bowden Lever. Turn Generator Shaft gently until the peak of the Cam passes the piston in cylinder and then turn back until you can just feel the peak of the cam brush past the piston.

Mesh the Gear wheels with the blade in the correct position relative to the axis of the gun barrel.

11. *Faults.* Possible faults which will cause slowing down of firing pin:—

- (a) Thick rim cartridge.
- (b) Protruding cap.
- (c) Fault in feed preventing recoiling portions going home, and extractor horns, therefore, catch against the under side of solid cams.
- (d) Too light a fusee spring.
- (e) Recoiling parts too heavy.
- (f) Faulty fitting of empty clip chute.
- (g) Weak lock spring.

*NOTE.* At 1200 revolutions per minute of propeller 1/1000th of a second delay will cause shot to be 7.2 degrees late.



# Table of Timing of Interrupter Gears.

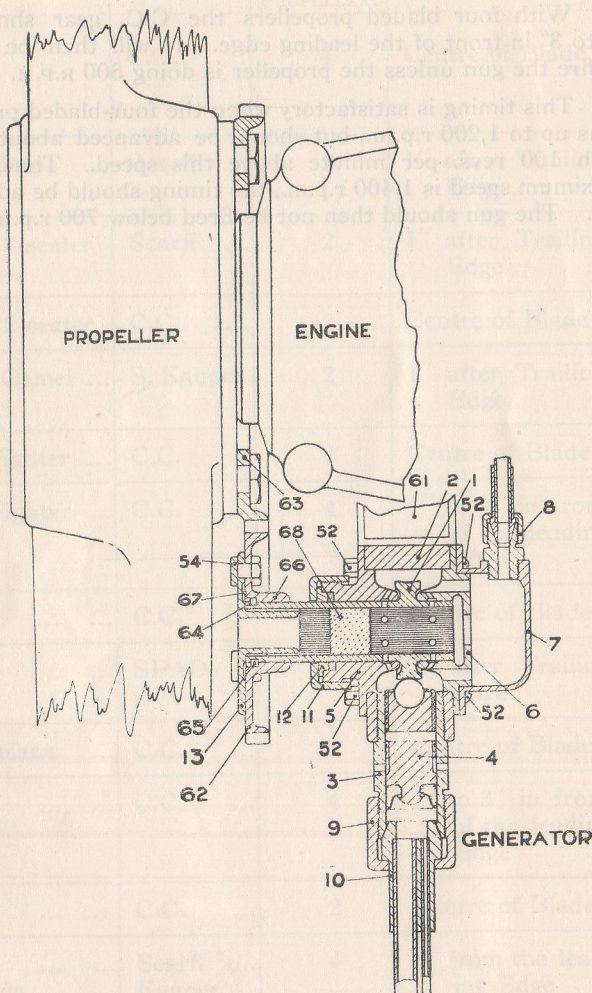
MACHINE.	TYPE OF GEAR.	NO. OF BLADES OF PROPELLER.	POINT OF AIM.
R.E. 8....	C.C.	4	Centre of Blade
Sopwith Pup. ...	Scarff ...	2	1" after Trailing Edge
Sopwith 2-seater	Scarff ...	2	1" after Trailing Edge
Sopwith 2-seater	C.C. ...	2	Centre of Blade
Sopwith Camel ...	S. Kauper	2	1" after Trailing Edge
Bristol Fighter ...	C.C. ...	2	Centre of Blade
Bristol Fighter ...	C.C. ...	4	1" to 3" in front of the leading Edge
S.E. 5....	C.C. ...	2	Centre of Blade
SPAD ...	SPAD ...	2	1" after Trailing Edge
A.W. Biplane ...	C.C. ...	2	Centre of Blade
De H. 4 ...	C.C. ...	4	1" to 3" in front of the leading Edge
De H. 5 ...	C.C. ...	2	Centre of Blade
De H. 4 ... Westlands (first 50) ...	Scarff ... Kauper ...	4	6" from the leading Edge

As a general rule in the case of two bladed propellers the C.C. gear should be timed on the centre of the blade and any mechanical gear 1" after the trailing edge.

With four bladed propellers the C.C. gear should be 1" to 3" in front of the leading edge. It will then be unsafe to fire the gun unless the propeller is doing 500 R.P.M.

This timing is satisfactory when the four-bladed propellor runs up to 1,200 r.p.m., but should be advanced about 6° per each 100 revs. per minute above this speed. Thus, if the maximum speed is 1,400 r.p.m., the timing should be advanced 12°. The gun should then not be fired below 700 r.p.m.



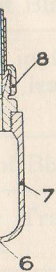


1. GENERATOR WITH DRIVING WHEELS AND BRACKET.

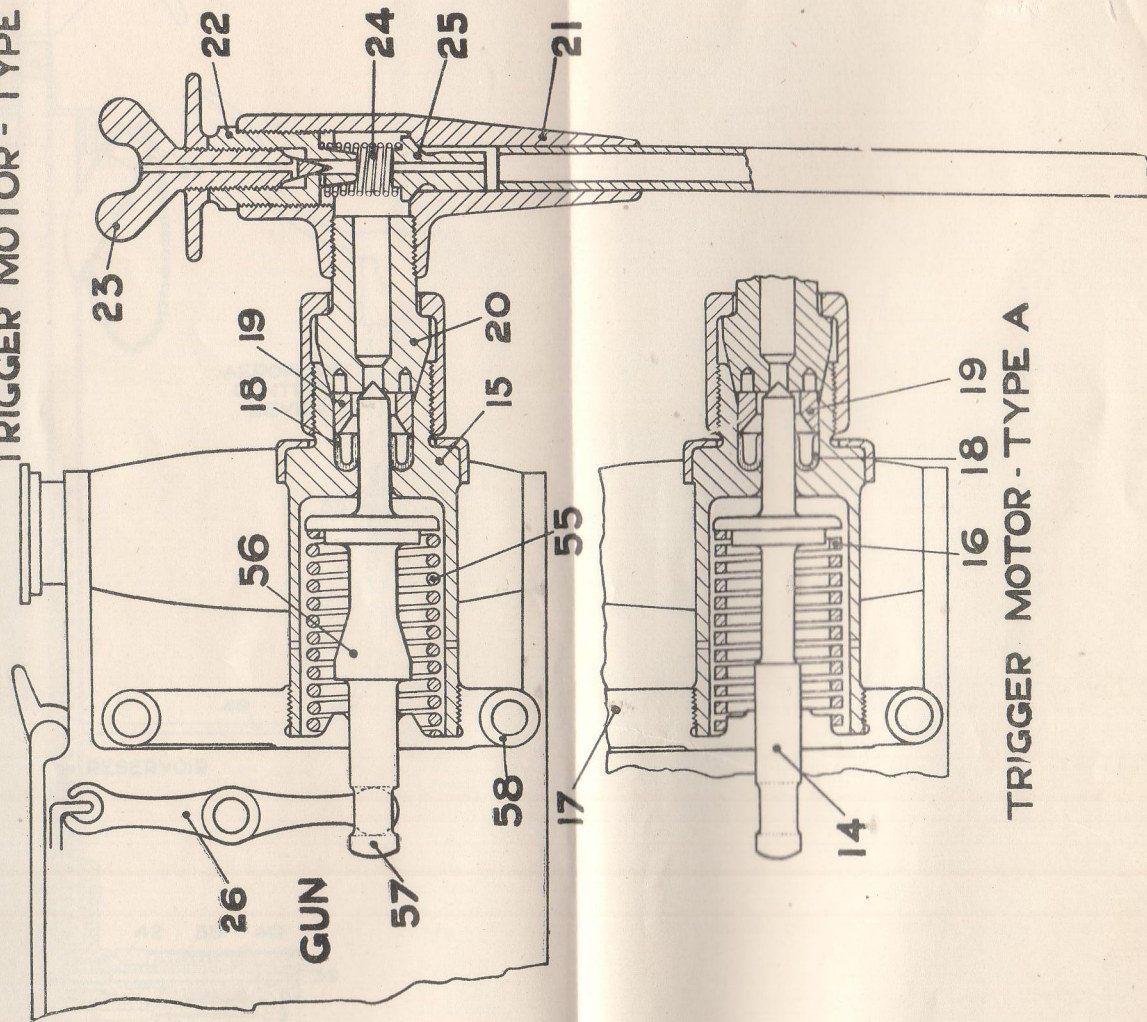


ERATOR

BRACKET.



TRIGGER MOTOR - TYPE A1



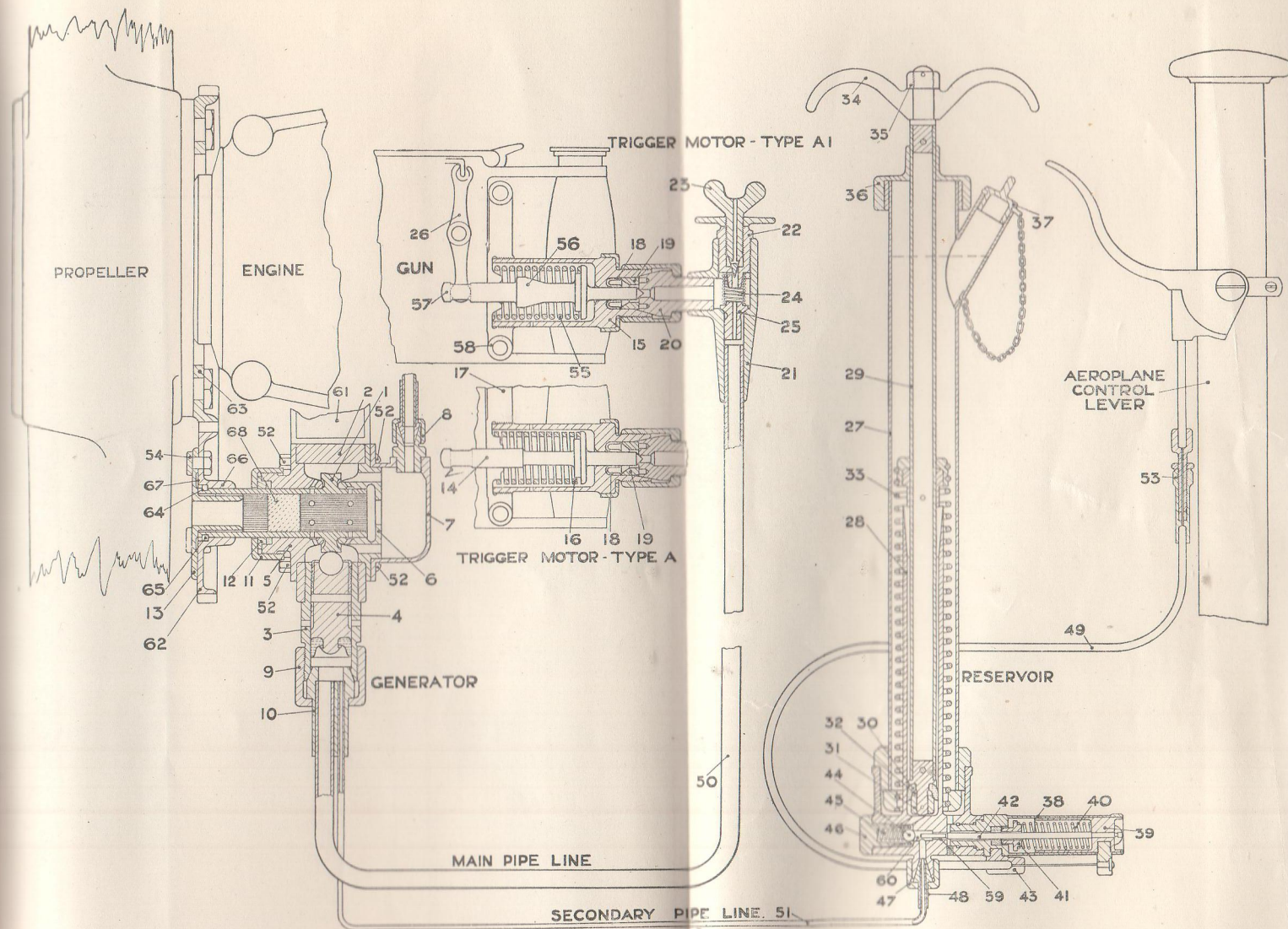
TRIGGER MOTOR - TYPE A

TRIGGER MOTORS, TYPES A AND A1.



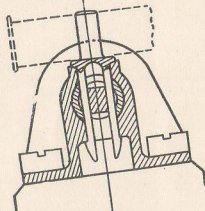
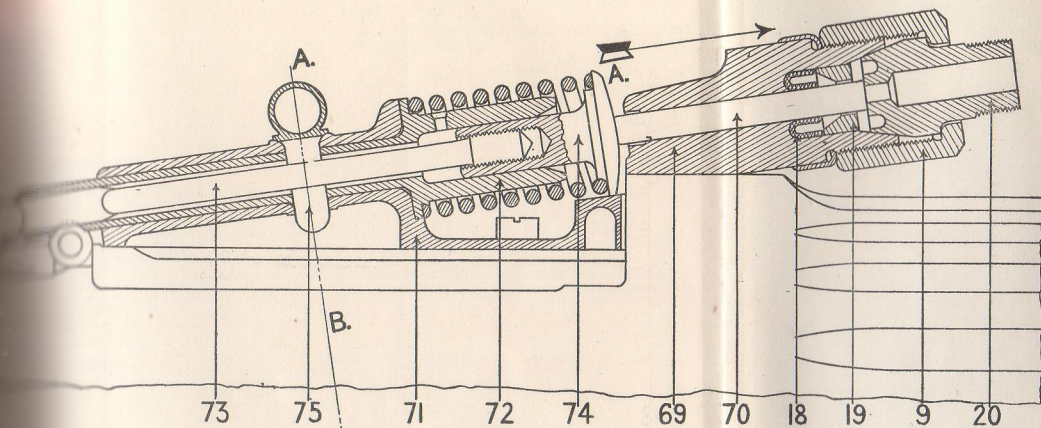




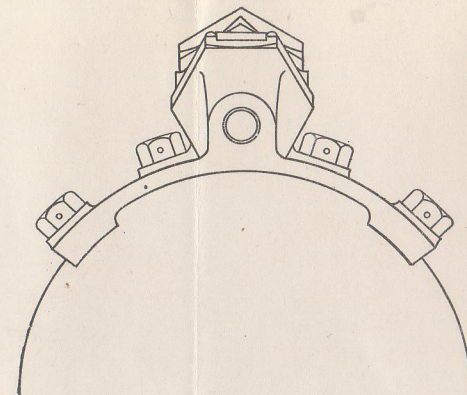


4. GENERAL ARRANGEMENT.

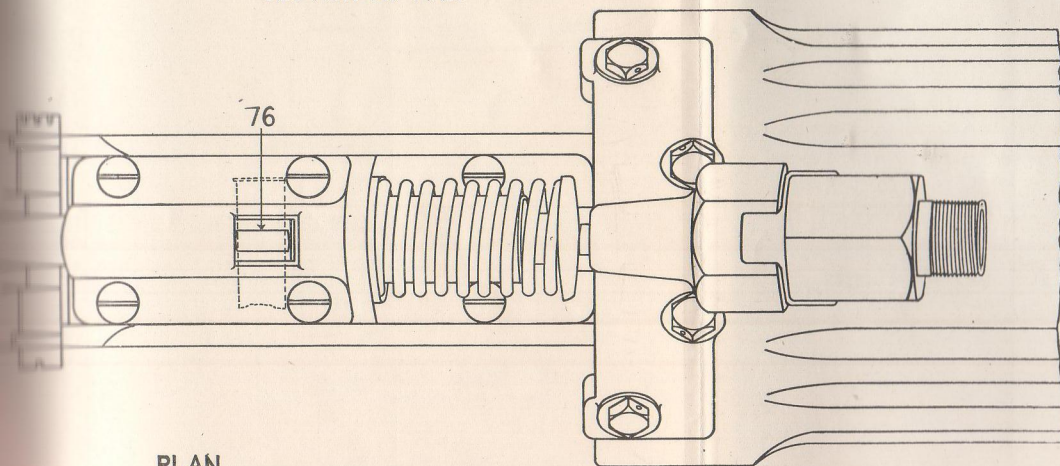




SECTION AT A.B.



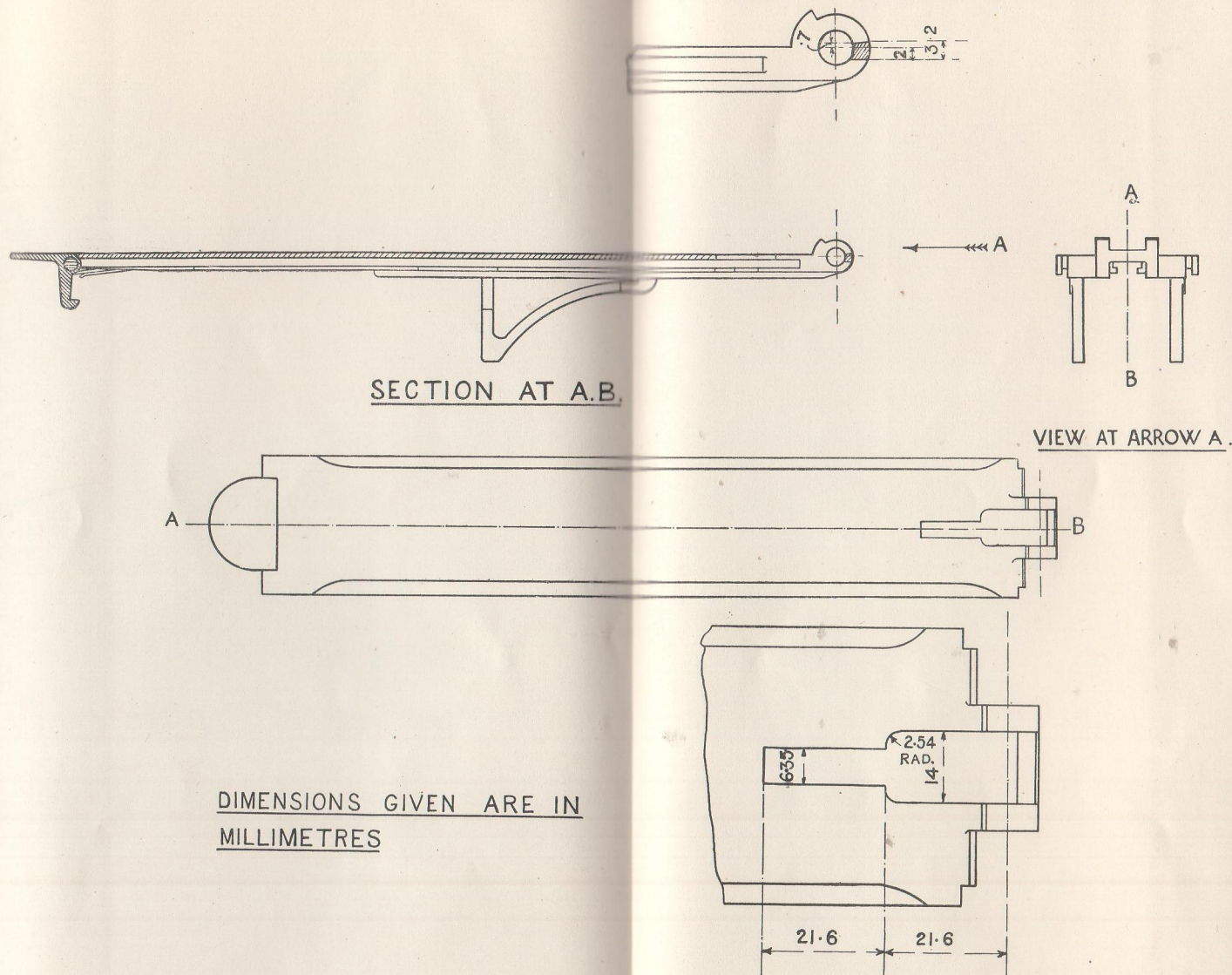
VIEW AT A IN DIRECTION OF ARROW



PLAN

5. TRIGGER MOTOR, TYPE B.

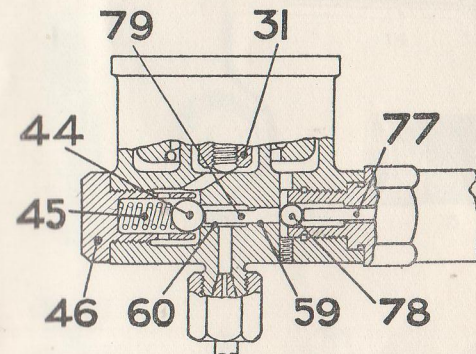




6. REAR COVER OF VICKERS GUN, SHOWING SLOT CUT AWAY TO SUIT TYPE B TRIGGER MOTOR.\*

\* Also suitable for Type C.





7. MODIFIED NEEDLE VALVE ARRANGEMENT FOR RESERVOIR.



